SUMMARY OFTHE GEOLOGY
OF THE SUMAS AND VEDDER MT. FAULTS

Dr. D.J. Easterbrook, Dr. D.C Engebretson, and D.J. Kovanen

Two faults, the Vedder Mt. fault and a previously unnamed fault that we now call the Sumas fault, have long been known along the sides of the Sumas Valley. However, new data now indicates that the faults are both larger and more active than previously known. The Vedder Mt. fault extends from British Columbia into Washington along the margin of Vedder Mt., continues southwesterly across Whatcom County (Figure 1), and appears to continue westward to Sucia Island in the San Juan Islands. The fault is at least 65 miles long and may be even longer. The Sumas fault parallels the Vedder Mt. fault and extends southwesterly from British Columbia through Sumas and across Whatcom County. The Sumas Valley has been dropped down between the Vedder Mt. fault and Sumas fault to form the Sumas graben, filled with at least 1000 feet of unconsolidated clay, silt, and fine sand (Figure 2). The thickness of unconsolidated sediments indicates the amount of down-dropping of the valley floor and that it is geologically young. The total amount of offset along the Vedder Mt. fault is at least 1000 feet plus the height of the fault plane along the side of Vedder Mt. (1500'). Thus, the total amount of movement on the fault is at least 2500 feet (Figure 3). The fault is buried by glacial deposits southwest of Vedder Mt., but its extent can be traced below the surface by the depth of water wells to bedrock.

Seismicity

More than 500 earthquakes of magnitude 2 or greater occurred in Whatcom, Skagit and San Juan counties between 1969 and 1993. Ten historic quakes with magnitudes 4 to 7.4 occurred between 1872 and 1969. The region near Deming is among the most active earthquake zones in the state with hundreds of quakes since 1969, including the April 14, 1990 quake (Richter magnitude 5.2), which was one of the five largest quakes in the Pacific Northwest between 1965 and 1992. A magnitude 5.0 earthquake occurred along the extension of the Sumas fault near Lynden in 1964 (Figure 4) and a magnitude 6.0 earthquake occurred in 1909 in the San Juan Islands near the distal trace of the Vedder Mt./Sucia fault. Many earthquakes have occurred along the trace of the Vedder Mt. fault since 1964 (Figure 5), indicating that the fault is presently active. Focal mechanism analysis of the earthquake epicenters indicates that the earthquakes are coming from an active, NE-SW-trending fault, upthrown on the south side, directly correlating with the conditions shown by the geology (Figure 5).

Seismic Risk Considerations

Seismic shaking

The intensity of an earthquake and its potential for damage depend on several factors:

(1) the larger the size of an earthquake, the greater the intensity of shaking. For example, bigger quakes cause more damage (on the Richter scale, a magnitude 6 is 10 times larger than a magnitude 5);

(2) nearness to the epicenter of the quake—for example, buildings closer to the epicenter receive more damage;

(3) the nature of the material beneath the ground. The size of seismic waves is much greater on clay and silt than on bedrock. (If you shake a brick and a bowl of jello, the jello produces much bigger waves, much like the difference between clay and rock in nature);

(4) the type of construction—large structures are more vulnerable than smaller ones and structures that vibrate with the same wave frequencies as those of earthquake waves may undergo greatly amplified shaking.

The Sumas Valley is especially vulnerable to earthquake damage because (1) it lies directly over the Sumas fault, (2) the Vedder Mt. fault lies only 2-3 miles away on the south side of the valley, (3) the thick fill of clay and silt in the valley (>1000') amplifies earthquake waves, and (4) lake clay and silt beneath the valley floor are subject to possible liquefaction. Principal areas of concern center around any facility that contains large quantities of flammable liquid or gas or toxic chemicals that could be released into populated areas.

Ground failure

During earthquakes, the ground may slide significantly. Failure of the ground beneath structures is highly destructive. Because of this, designing a large, earthquake-proof structure that could withstand ground failure is not possible.

Earthquake waves can cause clay, silt, and fine sand to act like liquids so that the ground literally flows, a process known as liquefaction. The floor of Sumas Valley is filled with many tens of feet of unconsolidated lake clay and silt that lie on more than 1000 feet of other fine-grained sediment. These sediments are vulnerable to shaking that could cause liquefaction. Figure 6 shows the area of the Sumas Valley underlain by sediment that has high-to-moderate liquefaction potential.

Offset of the land surface along a fault

Abrupt displacement along a fault can offset the land surface 15-20 feet in a single event. Such dislocations of the ground surface have occurred historically in Idaho, Montana, Wyoming, California, and other places. For example, Bainbridge Island jumped 20 feet out of Puget Sound along the Seattle fault about 1000 years ago. Although most fault movements do not break the ground surface, when they do, they are devastating.